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SF_6 TRACER GAS USED TO TRACE AIRFLOW THROUGH ABANDONED MINE WORKINGS

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by

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ABSTRACT

The tracer gas Sulphur Hexafluoride (SF_6) was used to confirm the continued existence of the underground connection between two abandoned collieries in the Sydney Coalfield. This report outlines the investigation and the results obtained.

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UTILISATION DU GAZ TRACEUR SF_6 POUR DÉCELER LE DÉBIT D'AIR DANS LES CHANTIERS DE MINE ABANDONNÉS

par

A.W. Stokes*

RÉSUMÉ

On a utilisé le gaz traceur SF_6 (hexafluorure de soufre) pour déceler l'existence de passages entre deux houillères abandonnées du gisement de charbon de Sydney. Le présent rapport donne un aperçu de l'investigation qui a été faite et des résultats obtenus.

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INTRODUCTION

It is general practice throughout the world to seal up the openings to coal mines at the end of their working lives. This precludes anyone gaining access into a potentially dangerous environment. As a further precaution ventilation stacks are usually mounted over at least one of the openings to allow the mine to 'breathe'. Thus prevencing the build up of gases under pressure inside to old workings which could perculate up to the surface via cracks and fissures in the ground.

On Saturday, March 3, 1973, a serious fire broke out in Number 12 Colliery, a submarine mine of the Cape Breton Development Corporation (CBDC). After unsuccessful attempts were made to extinguish the fire, it was decided to evacuate the men from the mine and place seals on the surface connections. An old worked out mine on the adjacent property (Number 14 Colliery) had been used to provide additional ventilation connections to 12 Colliery and thus a total of eight locations had to be sealed. Shortly after the seals were put in place a ventilation stack was erected over and connected via boreholes to the access slopes of each colliery. The distance between these is approximately 2 kilometres.

It is the policy of CBDC to analyse the gases vented from these stacks on a regular basis. This check is made to determine the presence of products of combustion and of explosive gases which could be a danger to residential houses in close proximity. Observations made by ventilation staff indicates that the flows in both stacks change direction frequently. The directions of flow in both stacks appears independent of each other.

A simple experiment was conducted using tracer gas to determine if the connections between the two collieries still exist, thereby confirming that the flow was between the stacks rather than air and gas entering through some unknown routes.

RELEASE OF TRACER GAS

The tracer gas used in this investigation was sulphur hexafluoride (SF_6) an inert and stable gas which is detectable using a gas chromatograph with an electron capture detector down to concentrations as low as a few parts per trillion (10^{-12}).

Examination of colliery ventilation staff records showed that the airflow in the shafts fluctuates, but that they usually found air downcasting the number 12 stack and upcasting through number 14. Therefore, on September 16, 1983, 26.3 g of SF_6 (4.1 L) was released from a lecture bottle into the air downcasting number 12 stack.

SAMPLING OF THE MINE AIR

Volumetric airflow in and out of the ventilation stacks was estimated to be in the order of a few cubic metres per minute. Given the large volume of the abandoned workings of the two collieries, it was felt that the SF_6 would be detectable in the vented airstream for many months after the injection. The samples were, therefore, collected from both shafts with a sampling frequency of two weeks or more.

Samples were collected in plastic syringes which were sealed with rubber stoppers. The author realizes that there are absorption/adsorption problems associated with collecting SF_6 in syringes, but as the purpose of the investigation was a qualitative assessment of the system (i.e. confirming the through connection) it was not felt to be of significance.

ANALYSIS OF THE SAMPLES

The samples were analysed in the laboratory using an S-CUBED MODEL 215 B9C gas chromatograph utilising an electron detector and optimised for detecting SF_6. A detailed description of the instrument, its operation and calibration is given elsewhere (1).

RESULTS OF THE ANALYSIS

Table 1 contains the results of the analysis performed on the samples collected from the stacks for the four-month period after the SF_6 injection. At no time during this four-month period was the airflow in the number 12 stack found to be upcasting and hence no samples were collected other than the original background sample.

SF_6 was first detected in the upcast air in number 14 stack in the sample taken on October 17, 1983, some four weeks after it was injected. It was then detected in all subsequent samples, the last of which was collected more than five months after the release of tracer gas.

CONCLUSIONS

No naturally occurring SF_6 was detected in the air venting from number 12 and 14 collieries.

SF_6 was detected in the air venting from the number 14 ventilation stack between two to five weeks after its introduction into the number 12 ventilation stack. This confirms the continued existence of a connection between the two mines and a through flow of air between the number 12 and 14 colliery stacks.

REFERENCES

1. Model 215 AUP Environmeter/Portable Tracer Gas Monitor. Operation and Maintenance Manual. (SSS-R-76-2978 - 1); January 1978.

Table 1 - Tracer gas concentrations in the air samples collected from number 12 and 14 ventilation stacks

Sampling Location	Date Taken	SF_6 Concentration (p.p.b.)
General body air from around No. 12 Colliery vent. stack	16:09:83	0
Air from upcasting No. 14 Colliery vent. stack	16:09:83	0
Air from uncasting No. 14 Colliery vent. stack	30:09:83	0
Air from upcasting No. 14 Colliery vent. stack	17:10:83	56
Air from upcasting No. 14 Colliery vent. stack	28:10:83	7
Air from upcasting No. 14 Colliery vent. stack	08:11:83	83
Air from upcasting No. 14 Colliery vent. stack	24:02:84	173

Weight of lecture bottle before gas release = 1509.0 g
Weight of lecture bottle after gas release = 1482.7 g
Weight of gas released 26.3 g